Division of Materials Chemistry
- Chemistry of Polymeric Functionality Materials -

http://www.scl.kyoto-u.ac.jp/~kohjshin/index.htm

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Visitors

Dr SCHAPER, Andreas	Philipps University in Marburg, Germany, 25 January - April 18 2004
Dr TRACZ, Adam	Center of Molecular and Macromolecular Studies, Polish Academy of Sciences, Poland, 12 March 2004
Mr WU, Ming-Chien	National Cheng Kung University, Taiwan, 5 July - 30 August 2004
Prof FAN, Zenglu	Xi'an University of Engineering Science and Technology, P.R. China 5 August 2004 - 29 January 2005
Dr KRACOVSKY, Ivan	Charles University, Czech Republic, 30 August 2004 - 30 June 2005
Prof ISMAIL, Hanafi	University Sains Malaysia, Malaysia, 14 - 31 December 2004

Scope of Research

Relationships between molecular arrangements and properties in polymeric functionality materials are investigated through electron microscopic observations and X-ray diffraction measurements elucidating the mechanism of higher-order structural formation. We focus on the studies of the role of crystallites in soft materials such as a natural rubber and a polymer gel. The major research subjects are as follows: (1) Strained-induced crystallization of natural rubber, (2) Ionic conductivity of uniaxially stretched elastomer, (3) Direct observation of molecular chains in the epitaxially grown lamellar crystals of polymers, and (4) Polymer gel consisting of the stereoregular polystyrene.

Research Activities (Year 2004)

Presentations

"High molecular weight branched poly(oxyethlene) as ion conducting elastomers", Kohjiya S, 5th Symposium of Fundamental Studies for Fabrication of All Solid State Ionics Devices, Tokyo, 28-29 January and other 3 presentations.

"Keynote: Dynamical studies on strain-induced crystallization of natural rubber vulcanizates using a synchrotron X-ray source", Kohjiya S, 4th International Materials Technology Conference & Exhibition (IMTCE2004), Kuala Lumpur, Malaysia, 23-25 March and other 1 presentation.

"3-D TEM and AFM observations of silica generated *in situ* in natural rubber", Kohjiya S, Katoh A, Shimanuki J, Hasegawa T, Ikeda Y, The 165th Spring Technical Meeting of Rubber Division, ACS, Grand Rapids, Mishigan, USA, 17-19 May.

"Preparation of nanocomposites composed of highly crystalline cellulose microfibrils and imogolite", Ikuno M, Hirai A, Horii F, Donkai N, Tsuji M, 53rd Spring Meeting, The Society of Polymer Science, Japan, Kobe, 25-27 May and other 6 presentations.

"Electron crystallography on beam sensitive materials - Part 1 and 2", Tsuji M, Invited lecture, International

Topics

Nano-structural Observation of In Situ Silica in Natural Rubber Matrix by Three Dimensional Transmission Electron Microscopy

Three dimensional (3D) nanostructures of particulate silica in natural rubber (NR) were observed for the first time by use of 3D transmission electron microscopy (3D-TEM), which is a combination of TEM with computer tomography, namely electron tomography. The method enabled us to visualize and evaluate structural characteristics in 3D space, such as the size and the volume of in situ silica generated in the NR matrix by the sol-gel reaction of tetraethoxysilane, at nanometer scale resolution.

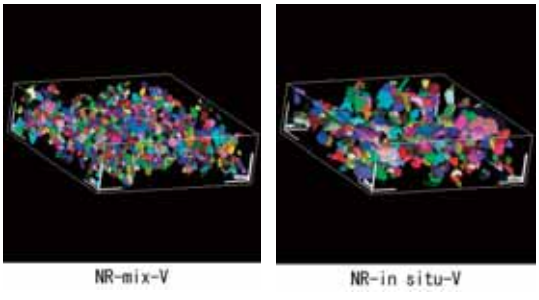

Figure 1. Colored volume rendered 3D views of the reconstructed mass density distribution of the silica inclusions for NR-mix-V and NR-in situ-V after removal of zinc compounds. The individual silica particles and aggregates were isolated from the neighbors by coloring. The frame is shown in reconstructed perspective geometry (length and width: 630 nm, thickness: 181 nm). The bar for each direction shows the distance of 100 nm.

Ionic Conductivity of Uniaxially Stretched Poly(oxyethylene)s

Elastomers are a group of materials with great deformability upon application of even a small stress. From this point of view, we study the effect of uniaxial stretching of the branched or linear poly(oxyethylene)s (PEO) on ionic conductivity. From the relationship between the lithium-ion conductivity along the stretching direction and the draw ratio of PEO films, we found the ionic conductivity increased with an increase of draw ratio at various lithium salt concentrations. The *in situ* measurements of wide angle X ray diffraction using a strong X ray source from a synchrotron radiation revealed that the degree of orientation of the crystalline chain of PEO was increased continually with an increase of the stretching ratio.

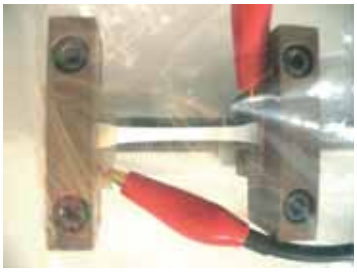

Figure 2. Ionic conductivity measurements with uniaxially stretched PEO.

School of Crystallography, 36th Course, "Electron Crystallography: Novel approaches for structure determination of nanosized materials", Erice-Sicily, Italy, 9-20 June.

"Past and future of natural rubber", Kohjiya S, Memorial lecture, 50th Meeting on Polymer Research, Kobe, 15-16 July and other 2 presentations.

"3D-TEM observation of in situ silica in natural rubber matrix", Kohjiya S, Ikeda Y, Katoh A, Shimanuki J, Sawabe H, Gonda M, Suda T, Kojima N, Nishioka M, Hasegawa T, 53rd Autumn Meeting, The Society of Polymer Science, Japan, Hokkaido, 15-17 September and other 4 presentations.

"Crystalline morphologies of unoriented and uniaxially oriented thin films of poly(butylene terephthalate) (PBT)", Yoshioka T, Tsuji M, Fujimura T, and Kohjiya S, 14th Symposium on Polymeric Materials, Kyoto, 1 December and other 1 presentation.

"Strain-induced crystallization in filled natural rubber vulcanizates", M, Poompradub S, Tosaka M, Murakami S, Kohjiya S, Ikeda Y, Toki, S, Sics I, Hsiao, B S, 17th Meeting on Elastomer (The Society of Rubber Industry, Japan), Kobe, 2-3 December and other 3 presentations.

Grants

Kohjiya S, Stress-induced crystallization behavior of natural rubber, Grant-in-Aid for Scientific Research, (B) (2), 1 April 2003 - 31 March 2005.

Tsuji M, High-resolution TEM of the shish-kebab structure in uniaxially oriented polyesters, Grant-in-Aid for Scientific Research, (C) (2), 1 April 2004 - 31 March 2007.

Kohjiya S, Feasibility investigation of all solid-state polymer electrolyte film, The funded research from NIC Corporation, 1 January - 30 June 2004.